Skin Circulation Measured By Fluorescein Flowmetry

AKADEMISK AVHANDLING
som för avläggande av medicine doktorsexamen vid Karolinska Institutet offentligen försvaras i Leksellsalen, Eugeniahemmet (T3), Karolinska Universitetssjukhuset i Solna.

Tisdagen den 31 Maj 2011, kl 13.00

av
Eduardo Proaño Romero. MD

Huvudhandledare:
Docent Leif Perbeck
Karolinska Institutet
Institutionen för molekylär medicin och kirurgi

Fakultetsopponent:
Professor Emeritus Olav Thulesius
Linköpings Universitet
Medicinska Fakulteten
Institutionen för klinisk fysiologi

Betygsnämnd:
Docent Universitetslektor Jan Östergren
Karolinska Institutet
Institutionen för Medicin Solna

Professor Henry Svensson
Lunds Universitet
Institutionen för kliniska vetenskaper
Avd för kirurgi och plastikkirurgi

Professor Tomas Jogestrand
Karolinska Institutet
Institutionen för Laboratoriemedicin
Avdelningen för klinisk fysiologi

Stockholm 2011

ABSTRACT

Fluorescein flowmetry (FF) is an indicator dilution technique using sodium fluorescein as an indicator. If the tissue is illuminated with U-V light or blue light, after a bolus injection of the dye, fluorescence is seen in the tissue, and can be measured either photographically or by the video technique. The development of the fluorescence pattern in the tissue in relation to time can be recorded and fluorescence curves constructed. A fluorescence index is calculated as the ratio between the maximal fluorescence obtained during the first circulatory passage of the dye and the rise time, defined as the time interval between 10 % and 90 % of the maximal fluorescence. This is an expression of the slope of the curve.

The aim of this study was to evaluate the suitability of FF for measurement of skin circulation.

The correlation was studied between FF and other methods regarding assessment of the change in skin circulation between initial measurements at rest and second measurements after provocation of vasodilatation. FF showed a coefficient of correlation (r) to the fast slope of the ^{133}xenon clearance curve of 0.46 ($p<0.05$), to the slow slope of the ^{133}xenon curve of 0.66 ($p<0.001$) and to laser Doppler fluxmetry (LDF) of 0.86 ($p<0.001$).

The coefficient of variation between two measurements of skin circulation with FF in the same healthy individual, with a one-month interval, in an incompletely dilated vascular bed, was 0.46, compared with 0.34 for LDF and 0.03 for skin temperature.

The relationship between weight-bearing pressure and skin circulation in the plantar region was studied in patients with diabetic neuropathy and healthy controls. Gait analysis was performed and skin circulation was assessed with the subject in the supine position, and standing and walking on a podoscope. The skin circulation was arrested at a pressure of 3Ncm^{-2} both in diabetic and control subjects. From 1.0 - 2.0 N cm^{-2} there was no difference in fluorescence index between these groups, but from 2.1 - 3.0 Ncm^{-2} there was a successive decline in index in the diabetic subjects, indicating a successive decrease in capillary closure pressure.

FF was used clinically in combination with LDF to determine how different surgical methods influence the circulation of the skin. The effects of the following operations were evaluated: a successful vascular reconstruction in patients with lower limb ischaemia; reduction mammaplasty with a bipedicle vertical dermal flap according to McKissock; and subcutaneous mastectomy and immediate breast reconstruction with implants in patients with breast cancer not suitable for lumpectomy. The influence of the site of skin incision on the circulation in the nipple-areola complex after subcutaneous mastectomy in breast cancer was also studied.

FF cannot be considered to measure blood flow per se in the skin, but it mimics the transport of small solutes both extra and intracellularly. In assessing a change in circulation, FF shows high correlation to other established methods that are considered to measure skin circulation, such as ^{133}xenon clearance and laser Doppler fluxmetry. However, due to the large individual variations, FF is more appropriate for comparisons between groups rather than between individual subjects.

The greatest advantages specific for fluorescein flowmetry are the possibilities of studying heterogeneous circulation and predicting tissue viability in large areas of the skin.

Key words: Skin circulation, Fluorescein Angiography.

ISBN 9789162825607